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Polarisation independent optical sampling using four- wave mixing

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Abstract: Polarisation independent optical sampling of an 80 Gbit/s signal is performed using four-wave mixing in a highly non-linear fibre with a polarisation diversity scheme.

OCIS codes: (060.4510) Optical communications; (060.2340) Fiber optics components

1. Introduction

In future Optical Time Division Multiplexing (OTDM) systems beyond 100 Gbit/s, Optical Sampling (OS) is an important tool in order to monitor the quality of the signal. OS has been demonstrated successfully using second order [1] and third order non-linear effects [2-3]. Due to its fast response, four-wave mixing (FWM) is a good candidate as non-linear process for the sampling of the signal. As FWM is inherently polarisation dependent, a bi-directional polarisation diversity scheme (PDS) has been implemented.

In this paper we demonstrate polarisation independent OS measurements at 80 Gbit/s using the PDS. The sampling is performed using FWM in 500 m of highly non-linear fibre (HNLF).

2. Experimental set-up

The experimental set-up is shown in Fig.1. The data stream is generated by a gain switched DFB (GS-DFB) laser with a 9.999990 GHz repetition rate and a pulsewidth of 5.3 ps.

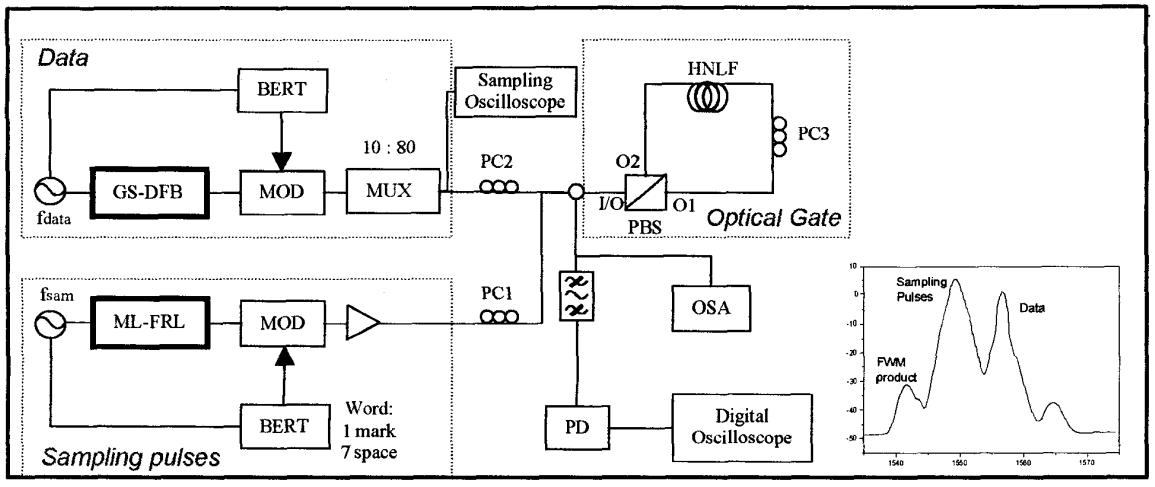

Fig. 1. Experimental set-up

The bit stream is externally modulated with a word of 8 bits and then multiplexed to 80 Gbit/s. The sampling pulses are generated by a mode-locked fibre ring laser (ML-FRL) with a 10 GHz repetition rate and a pulsewidth of 2.3 ps. The repetition rate is then reduced to 1.25 GHz by a second modulator. The two fields are coupled and then injected into the polarisation beam-splitter (PBS). PC1 is set to give the same power of the sampling pulses at O1 and O2. FWM take place independently and with the same efficiency in the two directions through the loop of HNLF. PC3 is used to maximise the output through the PBS to port I/O and acts on the clockwise and anticlockwise travelling light. PC2 is used to evaluate the polarisation independence of the scheme. In Fig. 1(right) is shown the

optical field at the output of the PBS. Using an optical pass-band filter, we filter out the FWM product and then feed it into a photodiode with a bandwidth of 100 MHz. Due to the low pass filtering effect of the photodiode we measure the envelope of the FWM product, thus reconstructing the data waveform on a reduced time scale.

3. Results

First we sampled data pulses at 10 GHz to characterise the optical gate. The results (Fig.2) show that the Extinction Ratio (ER) is 15.8 dB and the pulsewidth measured directly on the oscilloscope is 6.0 ps corresponding well to the data pulses. Adjusting PC2 we verified that the scheme is polarisation independent and we measured a residual polarisation dependence of only 0.7 dB due to a slight loss asymmetry in the loop.

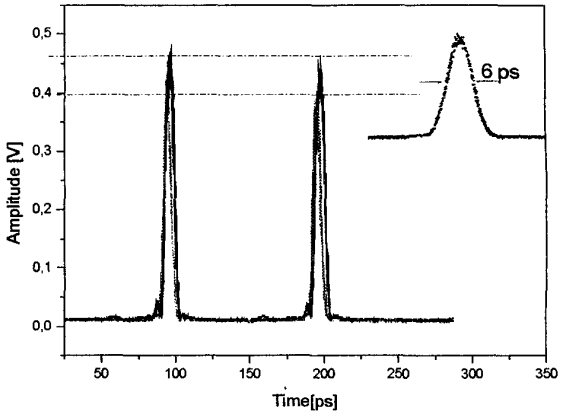

Fig.2. Sampled pulses in different states of polarization. Inset shows a close-up of the pulse

At this point we used the full set-up and we measured an 80 Gbit/s pattern. The results are shown in Fig. 3(rigth) and show that it is possible to resolve all channels with an ER of 10.5 dB. With this technique is possible to resolve the differences in amplitude of the different channels.

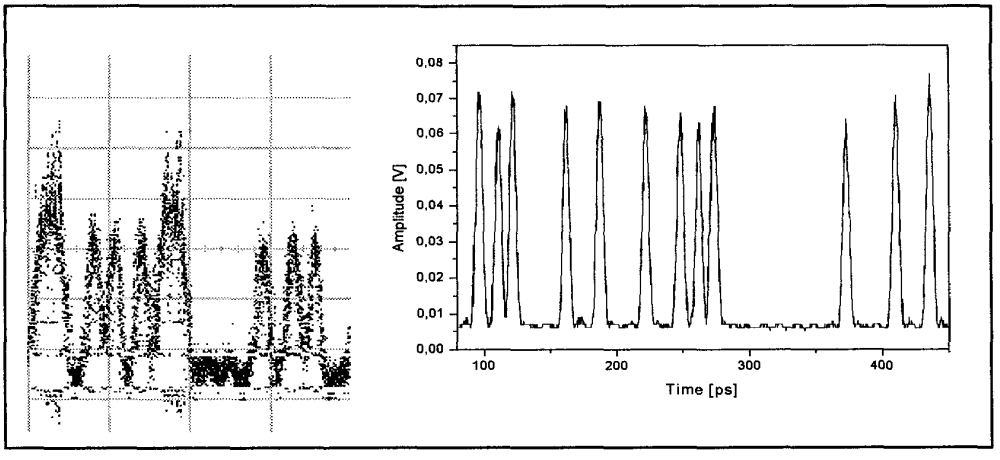

Fig. 3. Pattern of 80 Gbit/s data signal measured with the 30 GHz Sampling Scope (left) and with OS (right)

4. Conclusion

Polarisation independent all-optical sampling has been demonstrated at 80 Gbit/s. The residual polarisation dependence is 0.7 dB.

5. References

[1] H. Takara et al., "100Gbit/s optical waveform measurement with 0.6ps resolution optical sampling using subpicosecond supercontinuum pulses", Electron. Lett. **30**, 1152-1153 (1994)

[2] S. Diez et al., "160-Gb/s optical sampling by gain-transparent four-wave mixing in a semiconductor optical amplifier", Photon. Technol. Lett. **11**, 1402-1404 (1999)

[3] J. Li et al., "Measurements - 300-Gb/s Eye-Diagram Measurement by Optical Sampling Using Fiber-Based Parametric Amplification", Photon. Technol. Lett. **13**, 987-989 (2001)